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PHYTOTOXICOLOGY INVESTIGATION REPORT IN THE VICINITY OF LAIDLAW ENVIRONMENTAL SERVICES LTD. CORUNNA (1991)

MARCH 1993

Ontario

Ministry of
Environment
and Energy

6 apr/93

ISBN 0-7778-0791-2

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PIBS 2271

PHYTOTOXICOLOGY INVESTIGATION REPORT IN THE VICINITY OF LAIDLAW ENVIRONMENTAL SERVICES LTD. CORUNNA (1991)

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ARB-087-92

Section 1: Introduction

Laidlaw Environmental Services Ltd. (formerly Tricil Ltd.) at Corunna operates an industrial waste disposal facility that includes both the land filling of hazardous materials and the incineration of industrial wastes. There has been considerable public concern about the environmental impact of the company. Personnel of the Phytoxicology Section have been involved in numerous complaints of vegetation damage reportedly caused by emissions from Laidlaw. To date, only on one occasion has damage to vegetation been attributed to Laidlaw. This was the result of water runoff from the landfill site killing a number of trees immediately adjacent to the company (references 3-13 document historical Phytotoxicology activity around Laidlaw).

The Phytotoxicology Section has been conducting an annual assessment survey in the vicinity of Laidlaw every year since 1977, except for 1980 and 1988. The original survey consisted of 30 sampling stations within 8 km of the operation. The number of stations has changed from year to year. In the original survey, silver maple foliage and soil were collected. The 1978 and 1989 surveys were the only years soil was collected. Grass samples were collected during the four year period from 1978 to 1982. As no accumulation had been observed, the survey was reduced to 9 silver maple station in 1982. This was increased to 12 sites in 1984 and the distance increased to 12 km from the operation after a higher stack was installed. The survey was increased to 20 silver maple stations in 1989 and has stayed the same through 1991. Appendix A summarizes the type of samples collected and the number of stations sampled in each year.

The Phytotoxicology surveys that have been carried out since 1977, were to document any accumulation of **inorganic** contaminants in vegetation resulting from emissions to the atmosphere by Laidlaw. Up to 1984, no evidence of **inorganic** contamination of vegetation by the operation had been found in any of these surveys. A pattern of slightly elevated concentrations of some metals was first observed in the 1986 survey data, and upon closer examination was also found in the 1985 data. A similar trend was found in the 1987 survey results.

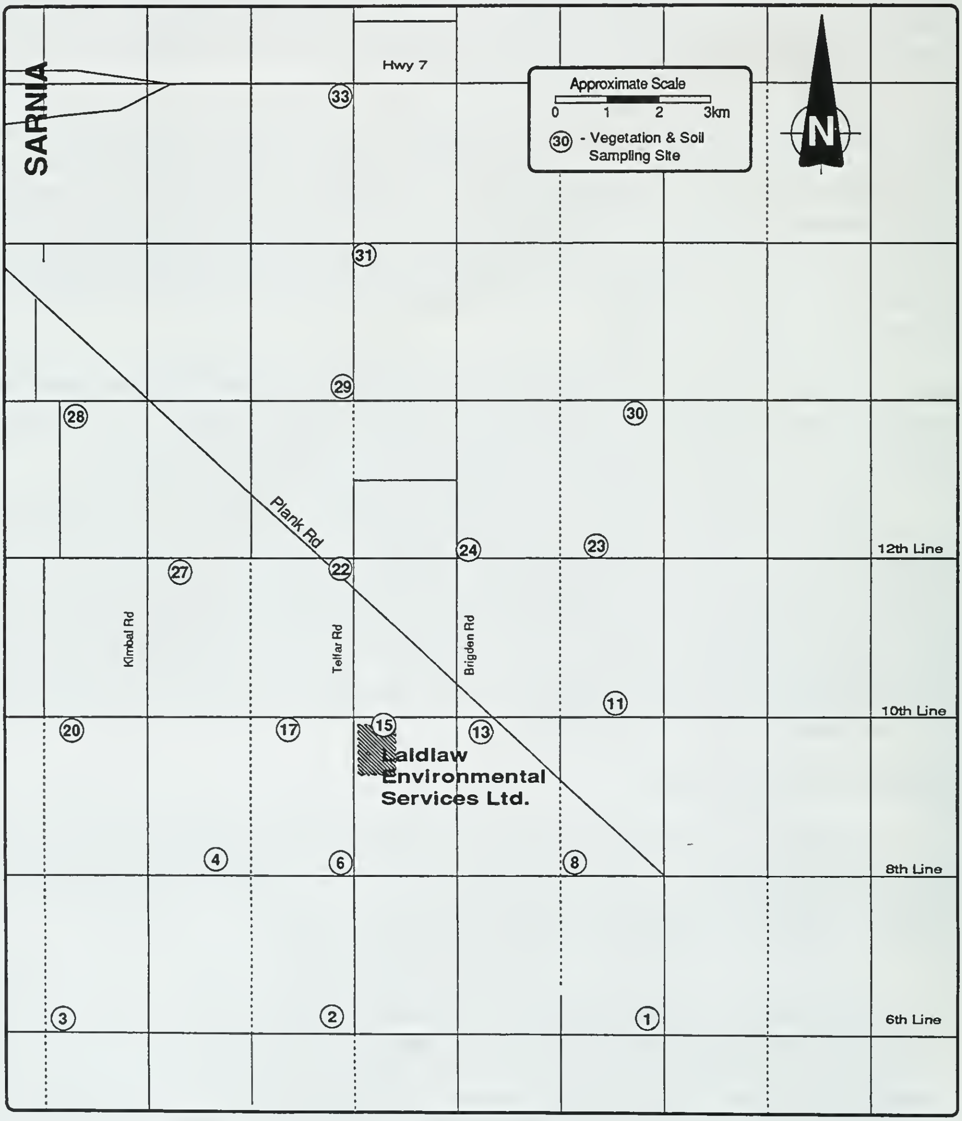
The 1987 survey found levels of chloride in silver maple foliage that exceeded the Phytotoxicology Section's Upper Limits of Normal (ULN) guideline (2). However, there was no pattern of excessive chloride that could be related to Laidlaw. It was assumed these high levels were due to the localized areas of high soil salinity that occur naturally in Lambton county. At the request of the Minister's office, the survey was expanded in 1989 and 1990 to determine if the high chloride levels were due to soil salinity or emissions from the Laidlaw operation. The 1989 and 1990 results were similar to those of the 1987 survey with marginally elevated concentrations of some metals in silver maple foliage around the company, but not in soil or moss bags. As in the 1989 and 1990 survey, chloride levels exceeded the ULN but there was no association with the Laidlaw operation (i.e. no concentration gradient related to distance or direction from the facility).

Section 2: Field Inspection

On August 22, 1991, Randall Jones and Craig Kinck of the Phytotoxicology Section, Air Resources Branch, Ministry of the Environment, conducted a vegetation survey in the vicinity of the Laidlaw operation. The same twenty locations within 12 km of Laidlaw sampled in the 1989 survey were sampled for silver maple foliage in 1991 (Figure 1). Duplicate samples were collected at each location for chemical analysis. Visual inspections were made of the native vegetation at each location for symptoms of air pollution injury.

The samples were collected using standard Phytotoxicology sampling techniques (1). All samples were delivered to the Phytotoxicology Section sample processing laboratory in Toronto where they were dried and ground before being submitted to the Inorganic Trace Contaminants Section, Laboratory Services Branch for inorganic chemical analysis. The silver maple foliage was analyzed for aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chloride, chromium, cobalt, copper, fluoride, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, nitrogen, phosphorus, potassium, selenium, sodium, strontium, sulphur, vanadium and zinc.

Figure 2.1: Approximate Locations of the 20 Silver Maple Sites in the Vicinity of Laidlaw Environmental Services, Corruna, 1991.



Section 3: Results

The analytical results are summarized in the following 6 tables. Also listed in each table is the Phytotoxicology Section ULN for each element, where available (2). Concentrations exceeding the ULNs have been underlined. The data are expressed as µg/g dry weight and are the mean of the duplicate samples collected at each site. Results reported as "DL" mean that the concentration is below the minimum reporting limit for the analytical method. Results followed by a capital "T" are considered tentative estimates or trace amounts.

There was no injury on any of the vegetation inspected in 1991 that could be related to air pollution. All of the injury that was observed was due to insects, disease or physiological stress. The tree at Station 3 showed severe drought stress injury, probably due to trenching in the soil around the roots.

Table 1: Concentrations* of Chemical Elements in Silver Maple Samples Collected in the Vicinity of Laidlaw Environmental Services, Corunna - August, 1991.

Site No.	Aluminum	Antimony	Arsenic	Barium	Beryllium
1	95	DL	DL	6.2	DL
2	65	DL	DL	5.7	DL
3	150	DL	DL	7.6	DL
4	100	DL	DL	4.6	DL
6	84	DL	DL	4.9	DL
8	140	DL	DL	6.5	DL
11	160	DL	DL	5.9	DL
13	100	DL	DL	10	DL
15	120	DL	DL	10	DL
17	120	DL	DL	4.5	DL
20	77	DL	DL	3.5	DL
22	63	DL	DL	5.2	DL
23	70	DL	DL	6.0	DL
24	130	DL	DL	6.2	DL
27	50	DL	DL	3.7	DL
28	170	DL	DL	7.1	DL
29	42	DL	DL	4.8	0.2T
30	97	0.2T	DL	5.9	0.3T
31	63	DL	DL	7.1	DL
32	51	DL	DL	5.2	DL
ULN	500	0.3	0.5	NG	NG
DL	5	0.2	0.2	0.5	0.1

*	- µg/g dry weight, mean of duplicate samples and analysis.
DL	- below the analytical method reporting limit
T	- trace amounts or tentative estimates.
ULN	- Phytotoxicology Upper Limit of Normal guidelines, see Appendix C.
NG	- No guideline, ULN not established

Table 2: Concentrations* of Chemical Elements in Silver Maple Samples Collected in the Vicinity of Laidlaw Environmental Services, Corunna - August, 1991.

Site No.	Boron	Cadmium	Calcium	Chloride	Chromium
1	46	DL	13,000	5,200	0.5T
2	75	0.10T	12,000	3,200	DL
3	31	0.17T	13,000	9,300	0.5T
4	39	DL	12,000	1,500	DL
6	51	DL	12,000	4,100	DL
8	41	0.12T	16,000	6,100	DL
11	52	0.12T	13,000	3,700	DL
13	48	DL	23,000	2,700	DL
15	46	0.18T	17,000	6,300	0.7T
17	46	DL	10,000	1,500	DL
20	34	DL	8,200	1,100	DL
22	54	0.10T	16,000	1,600	DL
23	58	0.10T	17,000	4,400	DL
24	43	0.10T	13,000	2,600	0.5T
27	38	0.10T	14,000	1,900	DL
28	42	0.12T	17,000	8,400	0.6T
29	22	DL	13,000	5,000	DL
30	47	0.10T	14,000	5,300	DL
31	76	DL	17,000	1,200	DL
32	33	DL	14,000	5,100	DL
ULN	75	1	30,000	1,500	8
DL	1	0.1	50	20	0.5

*	- µg/g dry weight, mean of duplicate samples and analysis.
DL	- below the analytical method reporting limit
T	- trace amounts or tentative estimates.
ULN	- Phytotoxicology Upper Limit of Normal guidelines, see Appendix C.
NG	- No guideline, ULN not established

Table 3: Concentrations* of Chemical Elements in Silver Maple Samples Collected in the Vicinity of Laidlaw Environmental Services, Corunna - August, 1991.

Site No.	Cobalt	Copper	Fluoride	Iron	Lead
1	DL	3.4	4.3	120	DL
2	0.3T	4.0	4.7	94	DL
3	0.2T	9.3	6.8	210	0.5T
4	DL	4.9	5.2	130	0.5T
6	DL	4.3	5.7	120	0.9T
8	DL	5.7	6.4	160	1.2T
11	0.3T	4.5	6.5	190	0.6T
13	0.3T	4.4	5.1	170	DL
15	0.3T	3.7	6.7	170	1.6T
17	0.3T	5.4	4.9	170	DL
20	0.3T	5.3	4.0	140	DL
22	DL	7.4	4.5	94	0.8T
23	DL	5.8	6.2	120	0.7T
24	0.2T	10	7.1	170	1.4T
27	DL	11	5.6	82	0.5T
28	DL	4.7	10	220	2.0T
29	DL	4.8	4.3	71	0.5T
30	DL	4.2	6.4	130	1.1T
31	DL	3.7	5.9	110	1.4T
32	DL	4.5	3.4	88	0.9T
ULN	2	20	15	500	30
DL	0.2	0.5	0.5	5	0.5

* - µg/g dry weight, mean of duplicate samples and analysis.
DL - below the analytical method reporting limit
T - trace amounts or tentative estimates.
ULN - Phytotoxicology Upper Limit of Normal guidelines, see Appendix C.
NG - No guideline, ULN not established

Table 6: Concentrations[*] of Chemical Elements in Silver Maple Samples Collected in the Vicinity of Laidlaw Environmental Services, Corunna - August, 1991.

Site No.	Sodium	Strontium	Vanadium	Zinc
1	27	200	DL	21
2	14	30	0.6T	18
3	1400	97	1.3T	32
4	22	38	DL	25
6	16	22	DL	24
8	20	34	DL	20
11	20	23	0.9T	25
13	22	36	DL	43
15	39	34	DL	35
17	22	44	0.7T	31
20	23	24	0.6T	20
22	18	32	DL	28
23	20	36	DL	28
24	23	22	0.7T	34
27	17	37	DL	38
28	46	25	1.1T	30
29	14	16	DL	20
30	17	22	DL	29
31	35	27	DL	35
32	13	16	DL	19
ULN	50	NG	5	250
DL	2.0	0.2	0.5	1.0

[*] - µg/g dry weight, mean of duplicate samples and analysis.
DL - below the analytical method reporting limit
T - trace amounts or tentative estimates.
ULN - Phytotoxicology Upper Limit of Normal guidelines, see Appendix C.
NG - No guideline, ULN not established

Table 5: Concentrations* of Chemical Elements in Silver Maple Samples Collected in the Vicinity of Laidlaw Environmental Services, Corunna - August, 1991.

Site No.	Nickel	Phosphorus	Potassium	Sulpher	Selenium
1	1.6T	2,000	7,100	1,400	DL
2	1.8T	1,900	6,100	1,500	DL
3	2.6	2,400	7,100	1,500	DL
4	1.5T	1,600	5,200	1,300	DL
6	1.7T	1,900	6,900	1,300	DL
8	1.9T	1,500	6,000	1,300	DL
11	1.5T	1,900	8,000	1,800	DL
13	2.4T	2,300	6,300	1,500	DL
15	1.9T	2,400	7,400	1,700	DL
17	1.7T	1,600	6,700	1,200	DL
20	1.4T	2,200	6,800	1,500	DL
22	1.7T	1,600	7,400	1,300	DL
23	2.5	1,700	6,000	1,800	DL
24	1.7T	1,500	9,400	1,400	DL
27	1.5T	2,400	9,300	1,900	0.22T
28	2.4T	1,400	6,400	1,300	0.20T
29	1.0T	1,500	7,800	1,600	DL
30	0.5T	2,500	8,400	1,300	0.22T
31	2.2T	2,300	7,400	1,300	0.22T
32	2.1T	1,500	8,000	1,400	DL
ULN	5	NG	NG	4,000	0.5
DL	0.5	20	20	100	0.2

*	- µg/g dry weight, mean of duplicate samples and analysis.
DL	- below the analytical method reporting limit
T	- trace amounts or tentative estimates.
ULN	- Phytotoxicology Upper Limit of Normal guidelines, see Appendix C.
NG	- No guideline, ULN not established

Table 4: Concentrations* of Chemical Elements in Silver Maple Samples Collected in the Vicinity of Laidlaw Environmental Services, Corunna - August, 1991.

Site No.	Magnesium	Manganese	Mercury	Molybdenum	Nitrogen
1	3,200	31	0.03T	DL	22,000
2	3,800	12	0.03T	0.2T	27,000
3	2,600	50	0.03T	2.3	23,000
4	4,700	20	0.02T	DL	20,000
6	3,500	37	0.03T	DL	19,000
8	3,800	34	0.03T	0.3T	15,000
11	3,000	27	0.03T	DL	21,000
13	4,600	120	0.03T	0.3T	21,000
15	4,200	30	0.04T	DL	23,000
17	3,200	18	0.02T	DL	18,000
20	2,800	27	0.03T	DL	21,000
22	3,100	17	0.02T	0.2T	21,000
23	5,000	44	0.03T	0.4T	17,000
24	3,200	41	0.03T	0.3T	16,000
27	2,800	10	0.04T	DL	24,000
28	3,900	29	0.04T	0.3T	16,000
29	2,900	17	0.01T	0.3T	19,000
30	3,500	18	0.03T	0.2T	19,000
31	3,900	15	0.02T	0.2T	19,000
32	3,500	27	0.01T	0.2T	19,000
ULN	7,000	NG	0.1	1.5	NG
DL	20	0.5	0.01	0.2	200

*	- µg/g dry weight, mean of duplicate samples and analysis.
DL	- below the analytical method reporting limit
T	- trace amounts or tentative estimates.
ULN	- Phytotoxicology Upper Limit of Normal guidelines, see Appendix C.
NG	- No guideline, ULN not established

Section 4: Discussion

Due to the large amount of data, the discussion has been formatted by individual element. Where there was sufficient range in the data contour maps were produced for each element.

Concentration contour maps were produced using the graphics program "Surfer version 4.0". The contour maps were only produced when there was a difference between the minimum and maximum values of greater than twice the minimum value. These maps are only statistical approximations of the spatial distribution of the different contaminants. The maps are only to be used to provide information on the approximate areas and/or patterns of contamination. They can not be used to determine the actual concentration of a contaminant at a location where samples were not taken.

The contours produced by the program are significantly affected by the spatial distribution of the sampling sites, the accuracy of the positional information of the sampling sites, and the program options used to generate the contours. The accuracy of the contours deteriorates at the edges of the map and in large areas where there are no sampling sites. Therefore, contours near the edge of the map should be interpreted with caution. Large areas without sampling sites were blocked out so no contours could be drawn through them.

The program options used in generating the contours remained constant for each map. The options used for the maps in this report were:

Grid Interpolation Method : Kriging
Search Method : Normal
    Search Radius : Full Width of Map
    No. of Nearest Points : 10
Grid Size : 25 x 25
Contour (in line) Smoothing : Yes
    Tension Factor : 2

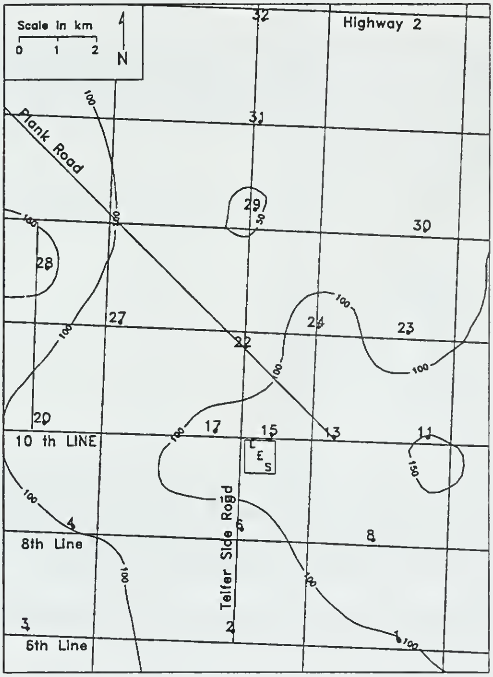
The contour interval, minimum contour and maximum contour are given at the bottom of each map. The units of measurement for the contours are the same as in the corresponding tables. The location of the sampling sites are indicated by a star with the sample site number immediately above, the approximate locations of major features, such as roads, are shown and the approximate location of Laidlaw is shown by a box with "LES" in the middle.

The prevailing winds during the non-winter months are from the west south-west, therefore emissions from the Laidlaw stack and landfill operations would be deposited predominantly to the east north-east.

4.1 Aluminum

The concentrations of aluminum in the silver maple foliage were all well below the rural ULN. While there were marginally elevated levels of aluminum in the silver maple foliage around Laidlaw and to the east (Figure 4.1), the pattern was not as distinct as in the 1989 and 1990 survey.

Figure 4.1:
Pattern of Aluminum in Silver Maple Foliage in 1991.



Contour Interval: 50 Min: 50 Max: 150 µg/g

4.2 Antimony

For antimony in silver maple foliage, all but one of the sites were below the analytical reporting limit of 0.2 µg/g (see Table 1). There was insufficient range in the data to produce a contour map. These results were similar to previous surveys.

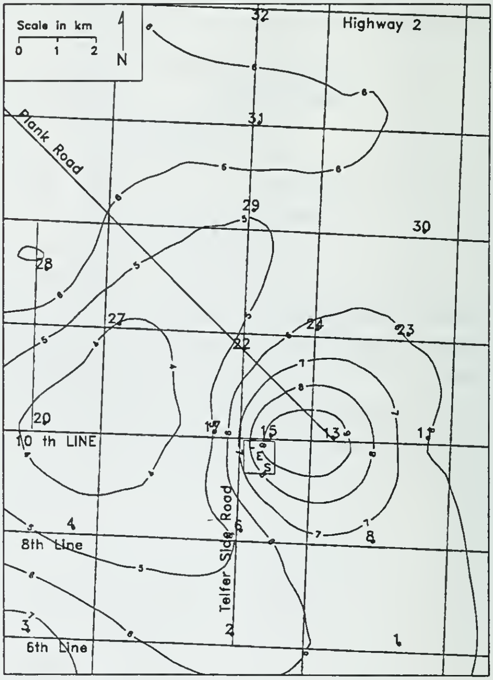
4.3 Arsenic

For arsenic in silver maple foliage, all of the sites were below the analytical reporting limit of 0.2 µg/g (see Table 1). There was insufficient range in the data to produce a contour map. These results were similar to previous surveys.

4.4 Barium

There was a pattern of marginally elevated barium in silver maple foliage around the Laidlaw operation (Figure 4.4). The pattern was more restricted in 1991 (station 15 and 13) than was observed in the 1989 and 1990 surveys. There is no rural ULN guideline for barium in silver maple foliage.

Figure 4.4:
Pattern of Barium in Silver Maple Foliage in 1991.

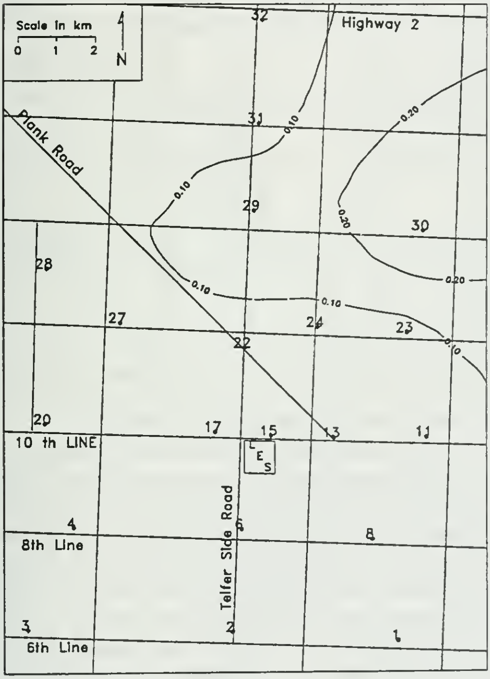


Contour Interval: 0.1 Min: 0.1 Max: 0.2 µg/g

4.5 Beryllium

The concentrations of beryllium in silver maple foliage were quite low with 18 of the 20 stations below the analytical reporting limit of 0.1 µg/g (see Table 1). The two stations above the reporting limit were to the northeast and did not appear to be associated with Laidlaw (Figure 4.5). The results were similar to the 1989 and 1990 surveys. There is no rural ULN guideline for barium in silver maple foliage.

Figure 4.5:
Pattern of Beryllium in Silver Maple Foliage in 1991.



Contour Interval: 0.1 Min: 0.1 Max: 0.2 µg/g

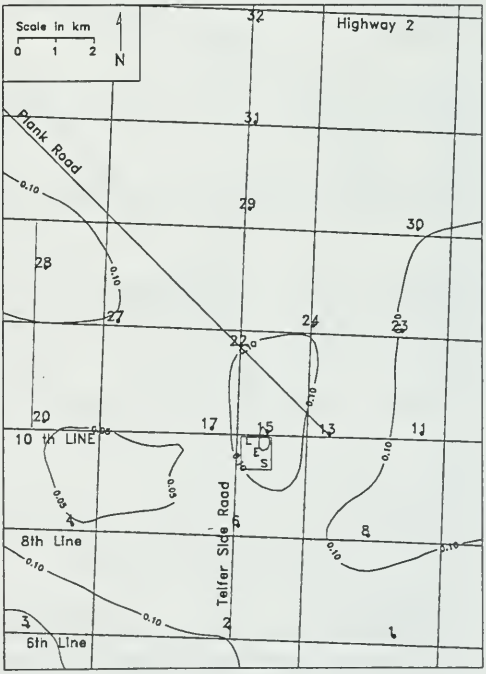
4.6 Boron

One of the silver maple foliage concentrations exceeded the boron ULN, however, there was insufficient range in the data for contour mapping (see Table 2). One other site equalled the ULN. Both of these anomalously elevated boron concentrations were either at upwind or distant sites. The results were similar to the 1989 and 1990 survey results.

4.7 Cadmium

The concentrations of cadmium in silver maple foliage were low, with all data being either below the analytical reporting limit or showing trace amounts (see Table 2). There were no exceedences of the cadmium ULN guideline. There was a marginally elevated pattern of cadmium around Laidaw, however, there was also a similarly elevated level at Station 3, which is upwind. As mentioned in the results section, the tree at Station 3 was suffering severe physiological injury and the elevated levels for a number of elements observed at this site may be due to the ability of dead leaf tissue to accumulate air borne contaminants. The pattern of cadmium in 1991 was not as distinct as in 1989.

Figure 4.7:
Pattern of Cadmium in Silver Maple Foliage in 1991.

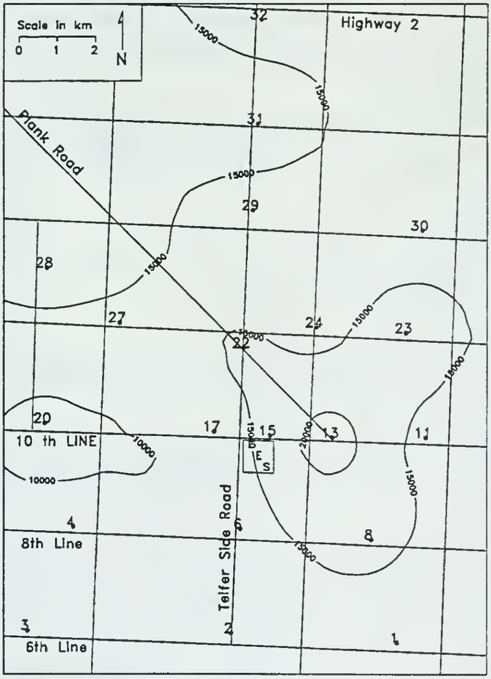


Contour Interval: 0.05 Min: 0.05 Max: 0.15 µg/g

4.8 Calcium

The calcium concentrations in silver maple foliage were moderately elevated but there were no exceedences of the rural ULN guideline (see Table 2). There was a pattern of marginally elevated calcium in silver maple foliage around the Laidlaw operation (see Figure 4.8). While the concentrations were similar to the 1989 and 1990 data, the pattern was different with the elevated concentrations more to the east of Laidlaw in 1991.

Figure 4.8:
Pattern of Calcium in Silver Maple Foliage in 1991.

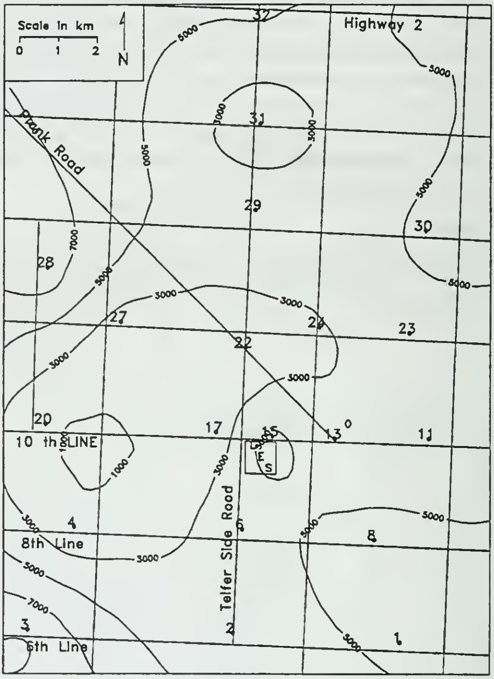


Contour Interval: 5,000 Min: 10,000 Max: 20,000 µg/g

4.9 Chloride

Chloride is of concern as it has been found to be a major constituent of emissions from waste incinerators. However, there is a potential problem with detecting accumulations of chloride in soil and vegetation around Laidlaw due to the naturally occurring salt deposits in Lambton county.

Figure 4.9:
Pattern of Chloride in Silver Maple Foliage in 1991.



Contour Interval: 2,000 Min: 1,000 Max: 9,000 µg/g

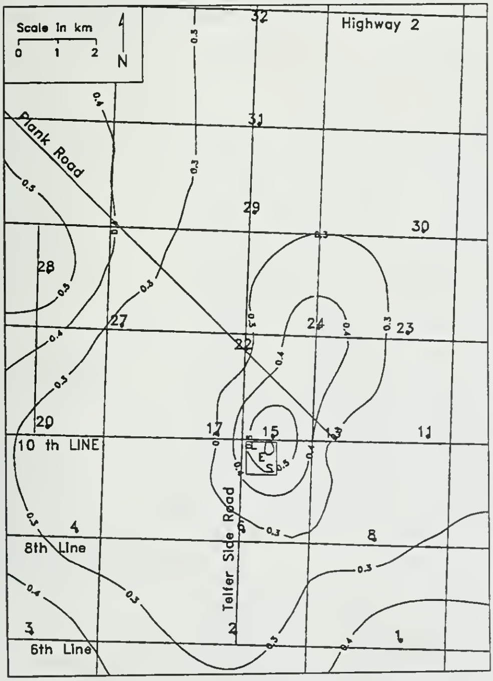
Chloride concentrations in silver maple foliage at 17 of the 20 stations in the 1991 survey equalled or exceeded the chloride ULN for vegetation (see Table 2). This was similar to what was found in 1987, 1989, and 1990, and is similar to what has been observed around other companies in Lambton county (from other Phytotoxicology surveys). Exceedences of the chloride ULN for foliage are not uncommon in Lambton county. The pattern of chloride in silver maple foliage, while not identical, was similar to the 1989 and 1990 surveys. There was a large area of very low chloride immediately west of Laidlaw (see Figure 4.9). There were a number of areas of elevated chloride scattered throughout the sample area. As mentioned in the results section, the tree at Station 3 was suffering severe physiological injury and the elevated levels for a number of elements observed at this site may be due to the ability of dead leaf tissue to accumulate air borne metals.

It would appear that localized deposits of elevated chloride in soil are the most likely cause of elevated chloride in silver maple in the sample area. There was no chloride concentration gradient relative to Laidlaw.

4.10 Chromium

All of the chromium concentrations in silver maple foliage were either below the analytical reporting limit or were trace amounts (see Table 2). However, there was sufficient range in the data to produce a contour map (Figure 4.10). There was a pattern of marginally elevated chromium centered on Laidlaw and extending to the northeast to Station 24. The pattern was similar to the 1989 survey results but the concentrations were lower in 1991. There were no exceedences of the chromium ULN for vegetation.

Figure 4.10:
Pattern of Chromium in Silver Maple Foliage in 1991.



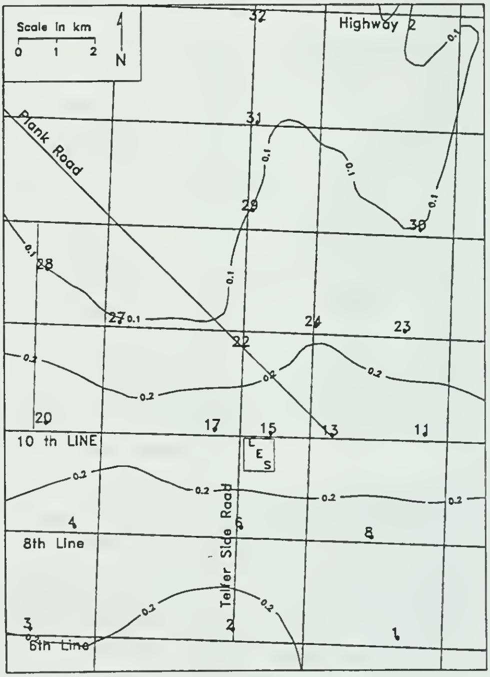
Contour Interval: 0.1 Min: 0.3 Max: 0.6 µg/g

These data indicate that Laidlaw may be a source of chromium. These elevated results are only observable because the natural chromium levels are very low and consistent, thus allowing for the detection of very small accumulations. It should be pointed out that these levels are only marginally above the analytical reporting limits and that none of the concentrations approach the rural chromium ULN.

4.11 Cobalt

The concentrations of cobalt in silver maple foliage were very low with all of the results below or near the analytical detection limit of 0.2 µg/g (see Table 3). None of the data were even close to the rural ULN guideline. There was no concentration gradient that could be related to the Laidlaw operations (see Figure 4.11). These results were similar to previous surveys.

Figure 4.11:
Pattern of Cobalt in Silver Maple Foliage in 1991.

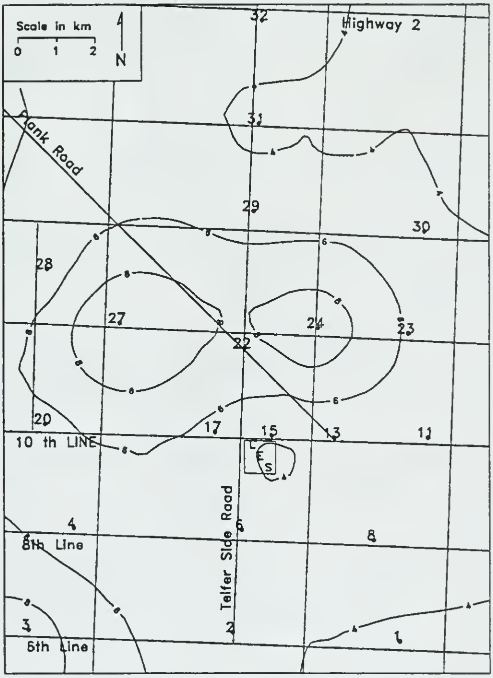


Contour Interval: 0.1 Min: 0.1 Max: 0.3 µg/g

4.12 Copper

All of the copper concentrations in silver maple foliage were below the rural ULN guideline (see Table 3). There was sufficient range in the data to produce a contour map (Figure 4.12). The concentration range and pattern were similar to the 1989 survey results. There were two areas of marginally elevated copper in silver maple foliage. One was to the southwest at Station 3 and the other larger area was to the north of Laidlaw between stations 24 and 27. There was no association with the Laidlaw operation.

Figure 4.12:
Pattern of Copper in Silver Maple Foliage in 1991.



Contour Interval: 2 Min: 4 Max: 8 µg/g

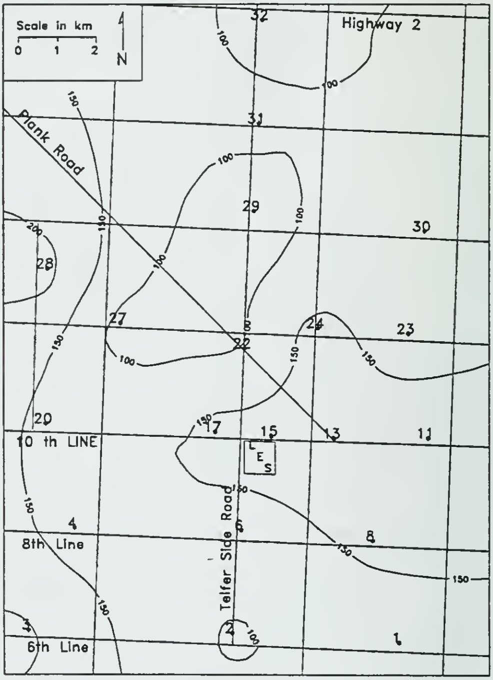
4.13 Fluoride

All of the fluoride measurements in silver maple foliage were below the rural ULN guideline (see Table 3) and there was insufficient range in the data to produce a contour map. The results were similar to those of previous surveys. Laidlaw does not appear to be an environmentally significant source of fluoride air emissions.

4.14 Iron

All of the iron concentrations in silver maple foliage were well below the rural ULN guidelines (see Table 3). While there was sufficient range in the data to produce a contour map, there was no pattern that could be associated with Laidlaw. Laidlaw does not appear to be an environmentally significant source of iron air emissions.

Figure 4.14:
Pattern of Iron in Silver Maple Foliage in 1991.

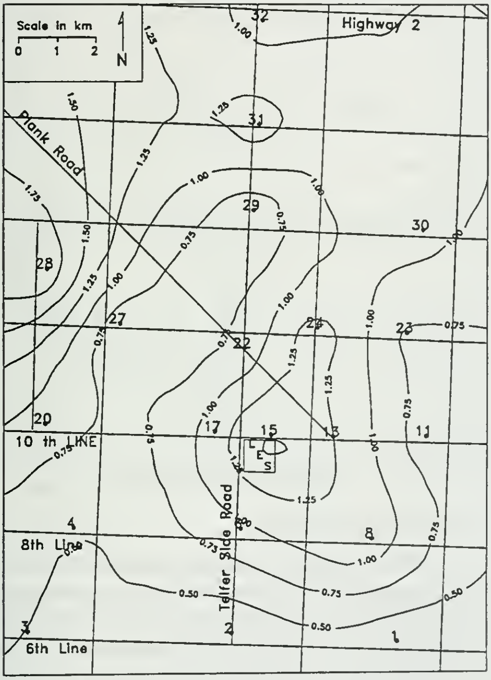


Contour Interval: 50 Min: 100 Max: 200 µg/g

4.15 Lead

All of the lead concentrations in silver maple foliage were very low (below the analytical reporting limit or trace amounts) and were well below the rural ULN guideline (see Table 3). There was a distinct pattern of marginally-elevated lead concentration centered around Laidlaw and extending to the northeast and southeast about 3 km. There was also a marginally elevated area around Station 28, about 6 km away and upwind from Laidlaw. These levels and patterns were very similar to the 1989 and 1990 survey results.

Figure 4.15:
Pattern of Lead in Silver Maple Foliage in 1991.

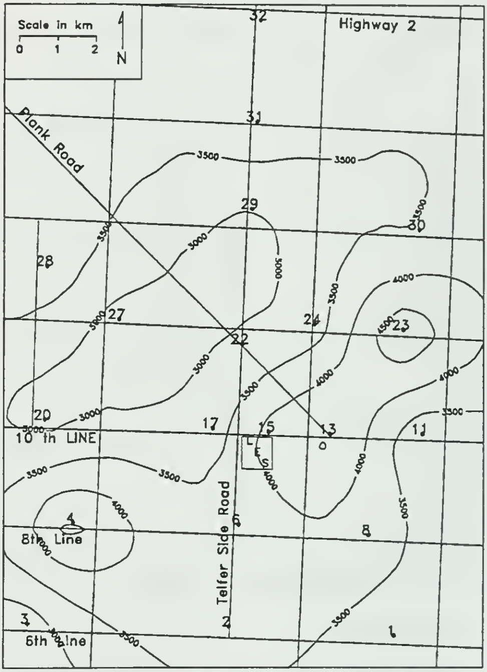


Contour Interval: 0.25   Min: 0.5   Max: 1.75 µg/g

4.16 Magnesium

Magnesium concentrations in silver maple foliage were well below the rural ULN guidelines (see Table 4). The concentrations were similar to the 1989 and 1990 survey results. There was a weak pattern of marginally elevated magnesium in silver maple extending from Laidlaw to Station 23 to the northeast (Figure 4.16). However, there are also two other areas of marginally elevated magnesium not associated with Laidlaw. Laidlaw does not appear to be an environmentally significant source of magnesium air emissions.

Figure 4.16:
Pattern of Magnesium in Silver Maple in 1991.

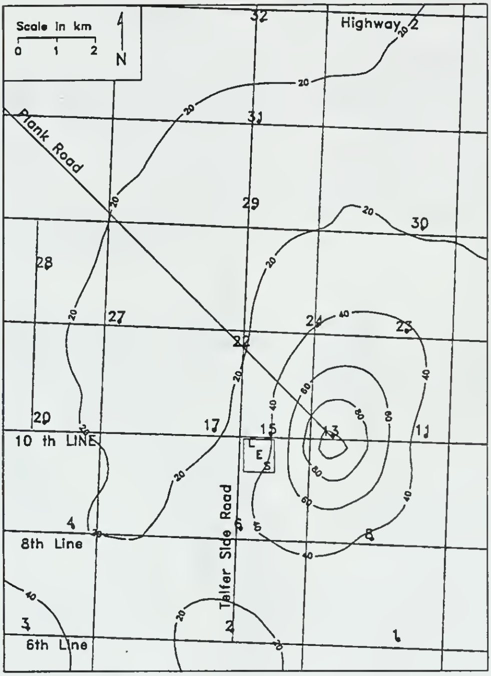


Contour Interval: 500   Min: 3,000   Max: 4,500 µg/g

4.17 Manganese

The manganese concentrations in silver maple foliage were low and similar to the 1989 and 1990 survey results. There are no rural ULN guidelines for manganese in foliage. The pattern of manganese in silver maple foliage was similar to the 1989 survey, except the concentration gradient to the east of Laidlaw in 1991 was due to the elevated level at Station 15. Laidlaw could be a minor source of manganese air emissions.

Figure 4.17:
Pattern of Manganese in Silver Maple Foliage in 1991.

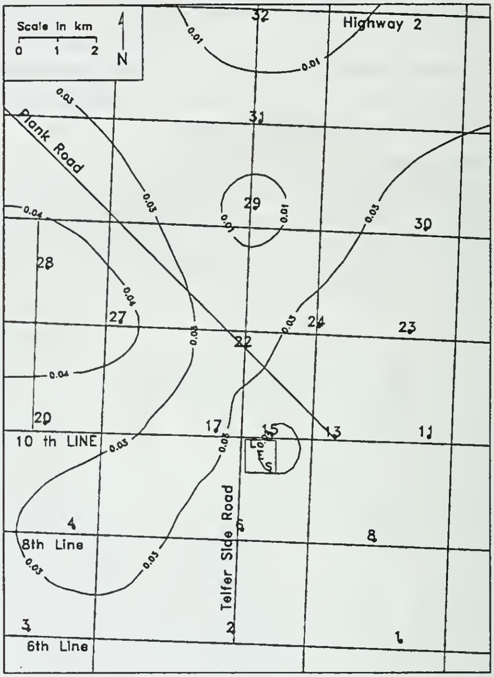


Contour Interval: 20 Min: 20 Max: 100 µg/g

4.18 Mercury

All of the silver maple foliage mercury concentrations were below the rural ULN guideline and all of the values were just above the analytical reporting limit (see Table 4). The range of values was similar to previous survey results. While there was sufficient range in the data to produce a contour map, there was no concentration gradient relative to Laidlaw (Figure 4.19). The pattern of low level mercury observed in the 1990 survey results was not repeated in 1991. Laidlaw did not appear to be an environmentally significant source of mercury air emissions in 1991.

Figure 4.18:
Pattern of Mercury in Silver Maple Foliage in 1991.



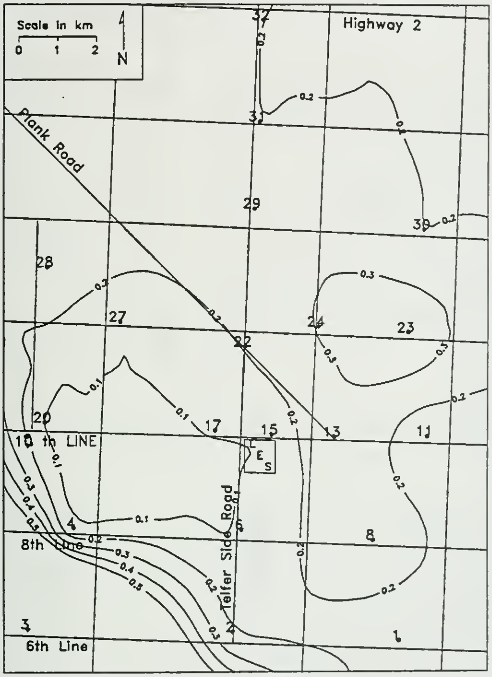
Contour Interval: 0.01 Min: 0.015 Max: 0.035 µg/g

4.19 Molybdenum

With the exception of station 3 all of the silver maple molybdenum concentrations were below the rural ULN (see Table 4). The data were around the analytical reporting limit of 0.2 µg/g. With the exception of station 3 the results were similar to previous survey results. As mentioned in the results section the tree at Station 3 was suffering severe physiological injury and the elevated levels for a number of elements observed at this site may be due to the ability of dead leaf tissue to accumulate air borne contaminants. While there was sufficient range in the data to produce a contour map (Figure 4.19), this range was only due to the high result at Station 3. There was no evidence of molybdenum accumulation in silver maple foliage as the result of air emissions from the Laidlaw operation in 1991.

Figure 4.19:

Pattern of Molybdenum in Silver Maple Foliage in 1991.



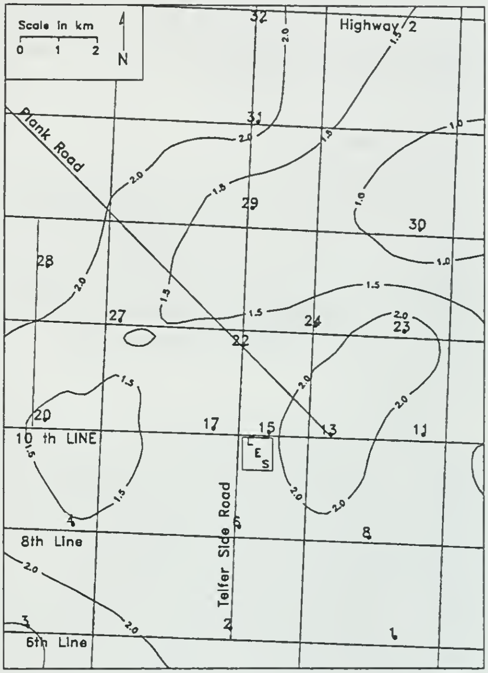
Contour Interval: 0.1 Min: 0.1 Max: 0.5 µg/g

4.20 Nickel

All of the silver maple foliage nickel concentrations were low. All but two were trace amounts, and all were below the rural ULN guideline (see Table 5). There was enough range in the nickel data to produce a contour map (Figure 4.20), but there was no distinct pattern of elevated nickel around the Laidlaw operation. Laidlaw did not appear to be an environmentally significant source of nickel air emissions in 1991.

Figure 4.20:

Pattern of Nickel in Silver Maple in 1991.



Contour Interval: 0.5 Min: 1.0 Max: 2.5 µg/g

4.21 Nitrogen

There is no rural ULN guideline for nitrogen in foliage. There was insufficient range in the data to produce a contour map (see Table 4). Laidlaw does not appear to be source of nitrogen.

4.22 Phosphorus

All phosphorus concentrations were below 3 mg/g and there was insufficient range in the data to produce contour maps (see Table 5). There is no rural ULN guideline for phosphorus in foliage. Laidlaw is not a source of phosphorus.

4.23 Potassium

There is no rural ULN guideline for potassium in foliage. There was insufficient range in the data to produce a contour map(see Table 5). Laidlaw does not appear to be source of potassium.

4.24 Selenium

All but four of the silver maple selenium concentrations were below the analytical reporting limit of 0.2 µg/g. The other four results were just above the analytical reporting limit (see Table 5). There were no exceedences of the selenium rural ULN for vegetation. Laidlaw did not appear to be an environmentally significant source of selenium emissions in 1991.

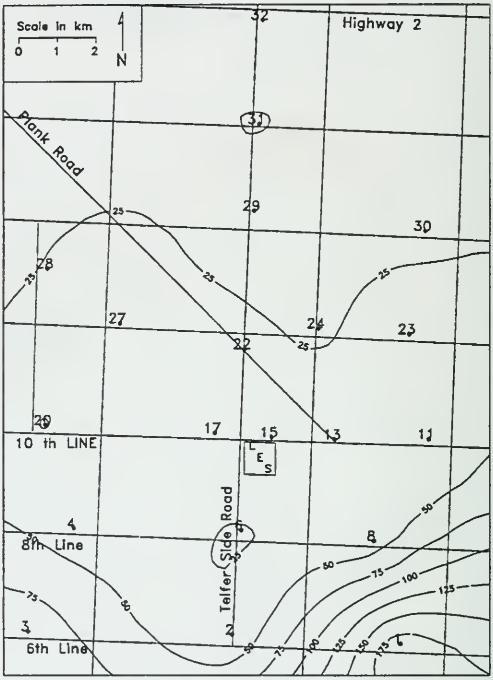
4.25 Sodium

With the exception of Station 3, all of the silver maple sodium results were below the rural ULN guidelines (see Table 6). At Station 3 the sodium concentration was almost 100 times the average for the rest of the stations. Chloride concentrations were also high at Station 3. As mentioned in the results section, the tree at Station 3 was suffering severe physiological injury and the elevated levels for a number of elements observed at this site may be due to the ability of dead leaf tissue to accumulate air borne metals. With the exception of station 3 the silver maple sodium concentrations were similar to previous survey results. When the Station 3 result was excluded there was not sufficient range in the data to produce a contour map. Laidlaw did not appear to be an environmentally significant source of sodium emissions in 1991.

4.26 Strontium

There is no rural ULN guideline for strontium in vegetation. All but two of the silver maple strontium concentrations were between 16 and 44 µg/g (see Table 6). Only Stations 1 and 3 were higher. There was no strontium concentration gradient associated with the Laidlaw operation. The only two elevated areas were around stations 1 and 3 well outside the Laidlaw zone of influence. Laidlaw did not appear to be an environmentally significant source of strontium emissions in 1991.

Figure 4.26:
Pattern of Strontium in Silver Maple Foliage in 1991.



Contour Interval: 25 Min: 25 Max: 175 µg/g

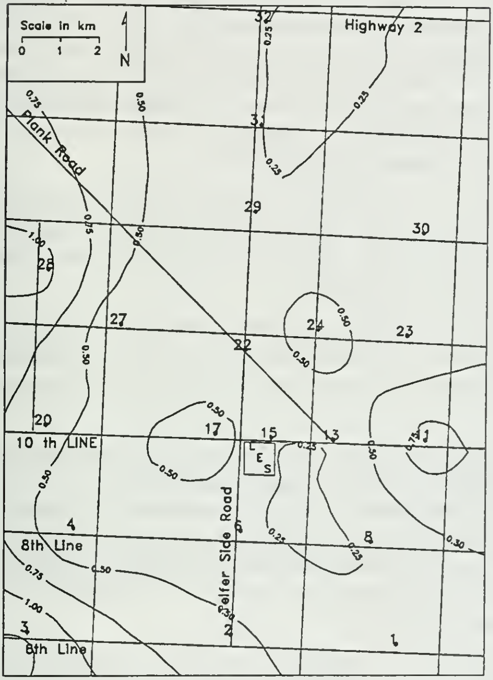
4.27 Sulphur

All of the silver maple concentrations were well below the rural ULN guideline for sulphur in foliage (see Table 5). There was insufficient range in the data to produce contour maps. Laidlaw did not appear to be an environmentally significant source of sulphur emissions in 1991.

4.28 Vanadium

Most of the vanadium concentrations in silver maple foliage were below the analytical reporting limit of 0.5 µg/g and there were no exceedences of the rural ULN guideline (see Table 6). While there was sufficient range in the data to produce a contour map, there was no pattern of elevated vanadium concentration that could be associated with the Laidlaw operation. Laidlaw did not appear to be an environmentally significant source of vanadium emissions in 1991.

Figure 4.28:
Pattern of Vanadium in Silver Maple Foliage in 1991.

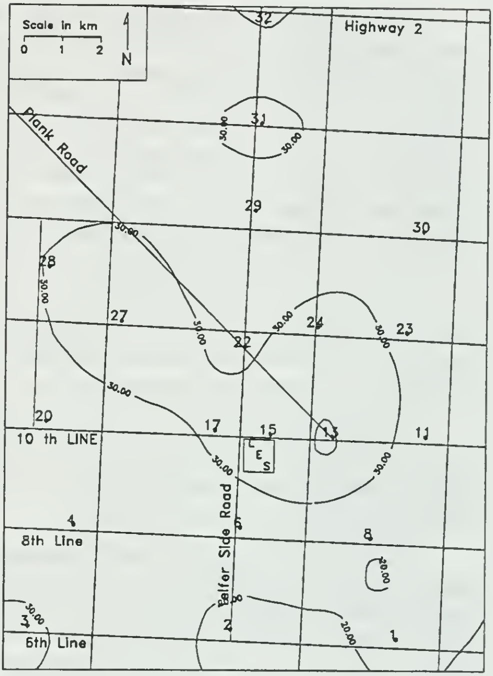


Contour Interval: 0.25 Min: 0.25 Max: 1.25 µg/g

4.29 Zinc

All of the silver maple zinc concentrations were low and well below the rural ULN guideline (see Table 6). The concentrations were similar to previous survey results. The contour map showed a area of marginally elevated zinc around Laidlaw extending to the northeast and northwest (Figure 4.29). While emissions of zinc from Laidlaw may be responsible for this marginally elevated zone, the concentrations are not significant.

Figure 4.29:
Pattern of Zinc in Silver Maple in 1991.



Contour Interval: 10 Min: 20 Max: 40 µg/g

Section 5: Summary

For 21 of the 29 inorganic parameters in silver maple foliage, there was either insufficient range between the minimum and maximum concentrations to generate a contour map or, where there was sufficient range, there was no concentration gradient associated with the Laidlaw operation. The chemical elements with elevated concentrations associated with Laidlaw could be separated into two types. The first type were those with a pattern of higher concentrations around Laidlaw but the pattern was not strong. These included aluminum, barium, calcium, cadmium, manganese, and zinc. The second group had very low consistent background levels with a marginal but distinct concentration gradient associated with the Laidlaw location. These included chromium, and lead. The elevated mercury concentrations in silver maple in 1990 were not observed in the 1991 survey. Even though these elements were elevated, none exceeded their corresponding rural ULN guidelines. In general, the extent of the zones of elevated concentrations were smaller and less distinct in 1991 compared to 1989 and 1990.

As with the 1987, 1989 and 1990 surveys, there were a large number of elevated chloride concentrations found in silver maple foliage in 1991. Even with the Surfer-generated contour maps there was still no apparent relationship between environmental chloride concentrations and Laidlaw. These elevated chloride concentrations are probably due to the localized deposits of salt (salt domes) in Lambton county.

It is not possible to distinguish between the incinerator or the landfill operation as the source of the elevated aluminum, barium, calcium, cadmium, mangenese, chromium and lead concentrations. However, the aluminum, calcium and manganese elevations could be related to dust created by the landfill operation. These are common components of the clay soil found in the area.

The 1991 survey report, like previous survey reports, concluded that Laidlaw is not a significant source of inorganic emissions to the atmosphere. However, based on the analysis of tree foliage and the computer-generated contour maps, Laidlaw, either through process emissions from the incinerator or fugitive emissions from the landfill, may be a marginal source of aluminum, barium, cadmium, calcium, chromium, lead, and manganese. In all cases, these concentrations were only marginally elevated above local background and did not exceed rural ULN guidelines for soil and tree foliage. Therefore, at this time, the degree of contamination was considered to be environmentally inconsequential and would not interfere with the normal use of the land.

The high concentrations of chloride in silver maple foliage were similar to the 1989 and 1990 surveys. As noted in the previous survey reports, the high chloride concentrations were not related to Laidlaw. It would appear that naturally occuring, localized, deposits of salt in soil are the most likely cause of elevated chloride in silver maple foliage in the sample area.

In light of the data obtained over a period of 14 years, and the limited potential for contamination documented to date, it is recommended that the survey frequency should be reduced to about once every three to (preferably) five years. This could be modified to more frequent visits if spills occur or if process changes are implemented.

Appendix A: Summary of Survey Activities

Year	Silver Maple	Grass	Soil	Moss Bags	Stations Sampled
1977	X		X		30
1978	X	X	X		30
1979	X	X			30
1981	X	X			30
1982	X	X			9
1983	X				8
1984	X				12
1985	X				12
1986	X				12
1987	X				12
1989	X		X	X	20[a] + 39[b]
1990	X			X	20[a] + 39[b]
1991	X				20

[a] - silver maple and soil stations.

[b] - moss bag stations.

Appendix B: References

(1) Ontario Ministry of the Environment, Air Resources Branch. 1983. Field Investigation Manual. Phytotoxicology Section - Air Resources Branch; Technical Support Sections - NE and NW Regions

(2) Ontario Ministry of the Environment, Air Resources Branch. 1989. Ontario Ministry of the Environment "Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples. Phytotoxicology Section - Air Resources Branch ARB-138-88-Phyto. ISBN: 0-7729-5143-8

(3) Ontario Ministry of the Environment, Air Resources Branch. 1977. A report of a Phytotoxicology Section survey in the vicinity of Tricil Limited, Corunna on August 3-5, 1977.

(4) Ontario Ministry of the Environment, Air Resources Branch. 1978. A report of a Phytotoxicology Section survey in the vicinity of Tricil Limited, Corunna on August 2-3, 1978.

(5) Ontario Ministry of the Environment, Air Resources Branch. 1981. A report of a Phytotoxicology Section survey in the vicinity of Tricil Limited, Corunna on July 30-31, 1979.

(6) Ontario Ministry of the Environment, Air Resources Branch. 1982. Phytotoxicology Assessment survey in the vicinity of Tricil Ltd., Corunna 1981 and 1982. ARB-PH-02-82-48.

(7) Ontario Ministry of the Environment, Air Resources Branch. 1984. Phytotoxicology Assessment survey in the vicinity of Tricil Ltd., Corunna 1983. ARB-105-84-PHYTO.

(8) Ontario Ministry of the Environment, Air Resources Branch. 1985. A report on the Phytotoxicology investigation of damage to vegetation in Lot 9, Concession 9, Moore Township, Ontario on August 21, 1985. ARB-163-85-PHYTO.

(9) Ontario Ministry of the Environment, Air Resources Branch. 1985. Phytotoxicology Assessment survey in the vicinity of Tricil Ltd., Corunna 1984. ARB-062-85-PHYTO.

(10) Ontario Ministry of the Environment, Air Resources Branch. 1986. Phytotoxicology Assessment survey in the vicinity of Tricil Ltd., Corunna 1984. ARB-233-85-PHYTO.

(11) Ontario Ministry of the Environment, Air Resources Branch. 1987. Phytotoxicology Assessment Survey Investigation in the Vicinity of Tricil Ltd., Corunna 1986. ARB-105-87-PHYTO.

(12) Ontario Ministry of the Environment, Air Resources Branch. 1988. Phytotoxicology Assessment Survey Investigation in the Vicinity of Tricil Ltd., Corunna 1987. ARB-086-88-PHYTO.

(13) Ontario Ministry of the Environment, Air Resources Branch. 1992. Phytotoxicology Section Investigation in the Vicinity of Laidlaw Environmental Services Ltd. (formerly Tricil Ltd.), Corunna, in 1989 and 1990. ARB-057-91-PHYTO.

Appendix C: Derivation and Significance of MOE "Upper Limits of Normal" Contaminant Guidelines

The MOE "upper limits of normal" contaminant guidelines essentially represent the expected maximum concentration of contaminants in surface soil (non-agricultural), foliage (tree and shrub), grass, moss bags and or snow from areas of Ontario not subject to the influence of point sources of emissions. "Urban" guidelines are based upon samples collected from centers of minimum 10,000 population. "Rural" guidelines are based upon samples collected from non-built-up areas. Samples were collected by MOE personnel using standard sampling techniques (ref: Ministry of the Environment, 1983. Field Investigation Manual. Phytotoxicology Section - Air Resources Branch: Technical Support Sections - NE and NW Regions). Chemical analyses were performed by the MOE Laboratory Services Branch.

The guidelines were calculated by taking the arithmetic mean of available analytical data and adding three standard deviations of the mean. For those distributions that are "normal", 99% of all contaminant levels in samples from "background" locations (i.e. not affected by point sources nor agricultural activities) will lie below these upper limits of normal. For those distributions that are non-normal, the calculated upper limits of normal will not actually equal the 99th percentile, but nevertheless they lie within the observed upper range of MOE results for Ontario samples.

Due to the large variability in element concentrations which may be present across Ontario, even in background data, control samples should always be collected. This is particularly important for soils, which may show large regional variations in element composition due to difference in parent material. Species of vegetation which naturally accumulate high levels of an element also may be encountered.

It is stressed that these guidelines do not represent maximum desirable or allowable levels of contaminants. Rather, they serve as levels which, if exceeded, would prompt further investigation on a case by case basis to determine the significance, if any, of the above normal concentration(s). Concentrations which exceed the guidelines are not necessarily toxic to plants, animals or man. Concentrations which are below the guidelines are not known to be toxic.